Review Article

Are artificial intelligence and co-active life coaching the future designers of nutrition and fitness matters?

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ABSTRACT

Purpose: New priorities for research are emerging in nutrition and sports sciences. These include application of artificial intelligence (AI) and coactive life coaching (CoALC) in nutrition and fitness worlds. Building off such link, this review aims to explore the up-to-date scientific literature at the intersections of AI and CoALC trends, and nutrition and fitness. **Design/methodology/approach:** A narrative review based on systems thinking approach was used to explore and discuss how AI concepts can affect nutrition and fitness matters, and how life coaching has attempted to deal with healthy lifestyles matters and with considerations of unintended related-consequences and health ethics. **Findings:** Systems thinking and transdisciplinary approaches could provide more understandings on how to better evaluate the impacts of AI concepts and CoALC and how they are significantly changing nutrition and fitness paradigms of production and consumption. Food and sports systems must continue to build their capacities to understand, regulate, and adapt to these changes. **Originality/value:** This study suggests a novel argumentative scenario that could be creatively adapted to generate effective strategies and advice on a controversial topic such as nutrition and fitness that involves values, personal attitudes and social behaviors. **Practical implications:** This paper provides a forward view of the use and impact of AI and CoALC on our dietary patterns and fitness behaviours, and on interventions methods in nutrition and health science research.

Keywords: nutrition; fitness; food systems; artificial intelligence; machine learning; coactive life coaching; systems thinking approach; open innovation approach; media

1. Introduction

Despite the ongoing controversies around many nutrients, and what may be the best diet for individuals, athletics, or specific nutrition-related diseases, there are an alarming lot we do currently know about the style of eating and exercising for most of us from dietitians, health experts, personal trainers, life coaches, media influencers, journalists, industrials, etc[1–3]. Hence, the distractions associated with such nutrition (dis-, mis-, lack-) information and sometimes exaggerated claims that are so much easier to access nowadays with the Internet of Things (IoT) are leading to public confusion and holding[4]. Adding to this confusion, several people with varying qualifications or fuelled by food and sports industries with a lot of money at stake are making a quick business by organizing events or publishing a book with a catchy and contentious title[1]. It is a common practice these days for lay citizens, who globally became trustful influencers on social media platforms and rated upon their followers' number, but with difficulty to remain impartial when they have personal or financial interest in the outcomes[1].

In response, nutrition scientists and academics who do not have conflicts of interests aim to inform people about the most state-of-the-art information and advice based on the best scientific evidence available. However, it is important to note that nutrition science hasn't always been justified and exact, and its historical evolution experienced a lot of scientific shifts that explains many uncertainties or controversies in nutrition today[5,6]. For instance, the early 1900's was a diligent epoch of discoveries in nutrition science especially research identifying several vitamins and treating common problems of nutrients deficiency diseases (e.g., scurvy and vitamin C deficiency) and nutrition adequacy[6]. In the second half of the 20th century called the "obesogenic era", attention had turned to the malnutrition problems and the related noncommunicable diseases (NCDs) such as obesity, cardiovascular diseases, hypertension, diabetes, eating disorders, etc[6]. Today, in both developing and developed countries, researchers, professionals, and industrials are focusing more on evidence debates, dietary patterns, ultra-modern sports products and services, and the double burden of malnutrition and NCDs[6–8].

Building on the existing scientific data around the multidimensional effects of distinctive food and nutrition matters, and fitness patterns, new priorities for research are emerging in nutrition and sports sciences. These include application of artificial intelligence (AI) in nutrition and sports[9]; and the potent influences of social and psychological status on individuals' dietary behaviours and active lifestyles[9–11]. Hence, a growing realisation of the importance of interactive customized coaching in motivating people to make healthy lifestyle changes[12] is highly consumed by the certified life and health coaches in the last few years[2,13].

However, to the best of our knowledge, there is little work done to examine the intersections of AI and CoALC trends and nutrition and fitness worlds. Building off such link, this review aims to map out the essential, promising, and challenging intersections by providing an overview of the contemporary literature.

In this manuscript, we present a brief yet comprehensive description of the basics of AI and CoALC, and then we discuss recent findings about AI and CoALC trends in the food, nutrition, and sports world. Moreover, this study offers a progressive view of the usage modalities and impact of AI and CoALC on our dietary patterns and fitness behaviours, and on interventions methods in nutrition and health science research.

2. Materials and methods

2.1. Data collection

To explore the up-to-date scientific literature at the intersections of AI and CoALC trends, and nutrition and fitness, this communication has implemented a narrative review to explore the notion of AI in nutrition and fitness on the one hand, and the notion of CoALC in nutrition and healthy lifestyle on the other. For that matter, most literature covering the use or application of AI concepts and CoALC model to nutrition and fitness matters in the last decade was collected from different sources including PubMed, Google scholar, institutional reports, etc. The databases were searched with several keywords and variations of the following: "AI and nutrition" or "AI and nutrition-related diseases" or "AI and food systems"; and "AI and fitness" or "AI and physical activity" or "AI and sports systems"; and "health coaching" or "life coaching" or "CoALC and nutrition" or "CoALC and health" or "CoALC and physical activity" or "CoALC and fitness" or "CoALC and sports".

By definition, a narrative review doesn't follow a specific protocol or definite search strategy neither have a predetermined research question. Only a predetermined "topic of interest" will guide this type of reviews[14]. Besides, such narrative method is also known by its purpose to identify a few studies that describe the topics of interests (e.g., AI and CoALC in nutrition and fitness worlds), and thus it was reasonable to include few eligible articles in the current research study[14].

In general, the application of CoALC to nutrition and fitness worlds is new and it is relatively modest compared to AI usage as a method of research and intervention in these fields. Therefore, a sample of 35

articles was collected. Of these, 24 articles covered AI and 11 articles covered CoALC topics and their relation to nutrition and fitness matters. Of the 24 articles of AI topics, 14 reported nutrition and nutrition-related matters (obesity, food technology, precision medicine, etc.), 6 reported fitness, and 4 reported food sustainability. Of the 11 articles of CoALC topics, only 2 articles reported fitness and 9 reported nutrition and nutrition-related matters.

2.2. Analysis

A systems thinking approach was used to explore and discuss how AI concepts can affect nutrition and fitness matters, and how life coaching has attempted to deal with healthy lifestyles matters and with considerations of unintended related-consequences and health ethics. Applying a "systems thinking" approach means taking into consideration the unpredictable interactions among several disciplines, sectors, key actors and determinants of nutrition and fitness matters[15,16]. Therefore, such approach helps to create the best possible processes to provide person-centered care, stimulates questioning, and promotes problem-solving[16].

After the literature review was completed and all duplicates were discarded, abstracts of selected remaining articles (N = 35) were reviewed to ensure that they address the research study objective. It is beyond the scope of this study to discuss all health matters and services, and here we focus on what is only significant to nutrition and fitness topics. Thus, a summary and synthesis of the findings from all selected articles was conducted and integrated into 2 categories: 1) AI, nutrition and fitness; and 2) CoALC, nutrition and fitness.

As a first step, this research summarized the fast-growing use of advanced technologies in food and sports systems. As a second step, we conducted a content analysis of the collected data to reveal the most commonly reported use of life and health coaching, specifically CoALC, in the nutrition and fitness fields. Finally, an in-depth synthesis was deployed in this research to propose an argumentative scenario based on open innovation approach to rethink nutrition and fitness with concepts and methods coming from different disciplines including AI and life/health coaching.

3. Results

3.1. Artificial intelligence, nutrition and fitness: From ambition to action

Nutrition is crucial to both health and economic development of nations, and to their sustainability, therefore it should be regarded as a catalyst for addressing interventions and informing policies to realise the 17 United Nations Sustainable Development Goals-UNSDGs[15,17–19]. Understanding the dynamics between the indicators of social determinants of nutrition, public health, and economics in societies, is fundamental to improve existing knowledge and data on nutrition, sports, health, and population statistics[17,20,21]. Previously, several types of studies and non-unified analysis were used to contribute to this crucial endeavour and to inform decision and policy makers on healthy lifestyles matters[21,22]. For instance, traditional bio- or para- medical studies in nutrition and sports sciences were largely based on hypothetico-deductive methodology using researchers self-generated knowledge to develop hypothesis and including different categories of informatics from the biological level to the population or epidemiological level in order to generate results and to achieve greater understandings of people's health choices, dietary behaviours and lifestyles[21,22]. Adapting these methodologies and analysis are commonly used in studying nutrition-related behaviours, food choice, purchase and consumption, and physical fitness habits and practices as significant factors for health prevention especially when addressing public health nutrition problems such as obesity[21].

Although such traditional approaches grounded in a priori assumptions and designed by researchers with objectives, procedures and limitations have enabled remarkable progresses in nutrition and fitness domains, they are now challenged by technology advancements that have helped enormously in fast processing, identifying, and analysing diverse and large amount of data that would be difficult for humans to discern[21,22].

Nowadays, artificial intelligence as a method for research to support traditional human problem solving (hypothetico-deductive or theory-based research) has gained so much traction across industries including food, sports, nutrition, and health for asking and answering better questions on their characteristics[9,17,21–24]. More specifically, the conceptual notions of AI-thinking such as machine learning (ML) were used carefully to analyse results produced by AI for understating the complex knowledge in healthy lifestyle real-world matters[22,25–27].

Several studies discussed the integration of AI and big data into smart systems and cities as a potential leverage point to transition to sustainable food systems[15,28,29], and to prevent nutrition-related diseases (such as obesity, gastrointestinal diseases, healthy active lifestyles, etc.) in smart healthcare systems[17,23,30–32]. Altogether, the findings summarized in **Table 1** indicate the adoption of advanced data-driven technologies in 3 inter-related groups of disciplines: nutrition, fitness, and food sustainability.

Table 1. Artificial intelligence in nutrition, fitness and food sustainability research.

Authors	Nutrition matters	Fitness matters	Food sustainability
Hamadeh S[15]	Smart food systems	-	Technological innovations for interventions & policies
Marqual IT Solutions Pvt. Ltd-KBV Research[33]	-	AI, ML in sports market & industry trends (apps, wearable devices, etc.) Coaches/analysts & sports decisions	-
Parnell D et al.[34]	-	Re-thinking sports	-
Ramkumar P et al.[35]	-	Sports medicine Automated tasks (AI-based tools)	-
Patel V et al.[23]	Gastrointestinal diagnostics	-	-
Bush C et al.[30]	Precision nutrition	-	-
Camarena S[28]	-	-	Transition to sustainable food systems
Flatt J[36]	Food technology Mapping phytonutrients Improve health & wellness	-	-
Hamadeh S[9]	Digitalized food systems E-food commerce Augmented reality apps Robot delivery services Virtual groceries	E-sports Personalized products & services Augmented reality apps	-
How ML and Chan YJ[17]	Malnutrition (under, over nourishment)	-	-
Liao H and Wang Z[18]	-	-	Precision agriculture Agri-food
Nadikattu R[37]	-	Sports apps Chatbots (fans seeking info & interactions) Robots & sports media coverage Connected products (shoes fitted with sensors)	-
Mellor D[11]	Precision nutrition Diet, gut microbiome & diabetes	-	-
Dube L et al.[38]	Convergent innovation in food Drivers of consumer behaviours Food science& technology Management, marketing & innovation (social media & AI)	Healthy lifestyle	Agriculture Environmental sustainability Ecosystem transformation solutions

Table 1. (*Continued*).

Authors	Nutrition matters	Fitness matters	Food sustainability
Hsu G[39]	Metabolic conditions Diabetes type 2 Cardiovascular diseases	-	-
Lee M et al.[40]	Open innovation 3D printing (food) Nutrition economy	-	-
Verma M et al.[31]	Precision nutrition	-	-
Zhu L and Zheng W[22]	Precision medicine approach Epidemiology	-	-
Marshall T et al.[21]	EScience & health research Obesity interventions	-	-
Tsimiklis P and Makatsoris C[41]	Food production and manufacturing	-	-

AI = artificial intelligence; ML = machine learning.

In interpreting this table, it is important to note that the adoption and use of common AI principles such as ML and AR is gaining traction outside the computer science studies. The supporting role of AI principles in nutrition and fitness worlds will advance existing knowledge on food chain processes, specific diets, personalized sports matters, and health-related matters including diabetes, malnutrition, metabolic syndrome, etc[9]. Besides, such precise information help to inform decision- and policy- makers in their practices related to public health nutrition interventions, food science and technology revolutions, health care programs, and the reform of sports products and services[9,17].

3.1.1. Significance of AI in food and nutrition

Over the span of years, researchers in nutrition developed general dietary and physical activity guidelines and recommendations with some specifications related to age groups, gender, and medical conditions but they failed considering the individuality of nutritional needs of people. Today, AI technologies help to identify and analyse the genetics and lifestyles information of individuals and thus, it enables more precise guidelines and recommendations tailored to the specific and unique nutritional needs of people[9].

Findings listed in **Table 1** showed that the usage of AI-based technologies in food and nutrition world was among the most important recent scientific development, which will accelerate understanding of the nutrients functioning and their impact on wellness and health[22,23,36,39], develop more personalized nutrition recommendations, and food products and dietary supplements for individuals and athletics[9,11,22,30,31,38], and facilitate the transition towards sustainable food systems by applying digital technologies to reduce food insecurity and waste issues throughout the entire food supply chain, so-called precision agriculture and precision food approaches for sustainability[9,15,18,28].

Eventually, AI has the potential to make significant contributions to food, nutrition, and nutrition economics sciences for the benefit of societies[40]. For instance, it will change the way researchers study nutrition and health-related matters (e.g., e-science and health research, precision nutrition, mapping nutrients, etc.)[11,17,21–23,30,36,39], and the way food businesses and consumers think about food production and services (e.g., evolution of food technology, 3D printing, virtual groceries, e-commerce, robot delivery systems, smart food systems, precision agriculture, etc.)[9,15,18,28,36].

3.1.2. Significance of AI in fitness

From precision nutrition and wellbeing, to fitness, athletic performance and sports medicine, AI is being widely used by sports industry to create new digital tools for tracking physical activity levels, dietary intakes, and health outcomes among populations[33,35,37,38]. Findings showed that sports apps and connected products

helped to collect, identify, and analyse specific information to create tailored fitness and dietary-related recommendations for individuals to meet their specific needs and reach their fitness targets[35,37,38]. Therefore, the use of AI technologies such as ML, chatbots, robotics among others is shifting the paradigm of fitness and sports world and inviting all stakeholders and decision-makers to re-thinking sports systems and embrace e-sports structure that is vastly esteemed in the modern smart economic societies[9,34]. Besides, the ability and fastness of AI in collecting and analysing large amounts of personal data enables new fitness services and products to market more quickly among consumers[33,37].

Ultimately, AI in fitness have the potential to offer data-driven decision support to sports industries, physical activity trainers and personal coaches, and analysts to identify patterns for more precise automated insights for the development or usage of new high-tech trendy products and services[9,35,37].

Findings from these studies showed that integrating technologies, AI concepts, and systems approaches helped to analyze a comprehensive range of data from interdisciplinary knowledge platforms and various inputs. Growing understanding of nutrition and fitness complexities contributes to a relevant and multifacted evidence, which will likely: 1) inform education and training programs; 2) provide the core for the development of evidence-based interventions and strategies; 3) enable more targeted and personalized guidance; and 4) arrange the groundwork for effective public health nutrition initiatives and policies.

3.2. Coactive life coaching for integrative nutrition and fitness

Nutrition was always a topic in which every individual feels in sense to be an expert who knows what the good and bad food are to choose. However, changing dietary patterns and lifestyles is not an easy task for people regardless of their health literacy level. Scientific evidence from nutrition and sports studies have shown that promoting autonomy and empowerment while fostering intrinsic motivation is essential to alter dietary patterns and sustain health behaviors among populations[20,42]. Similarly, the CoALC model, which has received special attention in recent years as a method to improve healthy lifestyles, aims to establish these conditions through its client-centered methodology and fundamental principles[2,24,43].

In particular, health coaching is a fast-growing area for work and research and has been utilized for ameliorating many chronic diseases and comorbidities[3,24,44,45], stress and anxiety management[46], and physical activity participation[47]. However, some findings indicated no consistent intervention effects or sustainable results in self-efficacy or perceived behavioral control with specific regard to weight problems, stress and anxiety, physical activity, etc., especially among youth who are not fascinated by coaching method[2,47].

There is a considerable number of various life coaching schools, but for the current review study only Co-Active coaching model (using sometimes motivational interviewing "MI-via-CoALC") was covered in the reviewed literature[48]. It must be acknowledged that some elements of coaching model such as self-efficacy, subjective norm, motivation, and others are shared with further theories and models (social cognitive theory, motivational interviewing, theory of planned behavior, etc.) that are commonly used in nutrition studies to understand and facilitate behavior change at the individual and/or community level[42,43,49].

For instance, social cognitive theory underlines an interaction between individuals, their environments and their behaviors[42], and therefore is considered an important interpersonal level theory specific to health behavior change. As such, the dynamic interaction between personal/cognitive-behavioral-environmental determinants, so-called reciprocal determinism, helped to better understand individuals' dietary and fitness behaviors in certain contexts based on their knowledge, skills, influence of social norms, and self-efficacy among other factors[42,43]. Likewise, the theory of planned behavior is widely applied to investigate the personal and psychosocial predictors of people intentions to change their dietary, fitness and health behaviors by studying and linking the following specific factors: attitude toward behavior, subjective norms, perceived behavioral control and behavioral intention[42,43,47]. To help improve self-efficacy, increase perceived behavioral control, and identify and strengthen levels of personal and social support among individuals,

motivational interviewing techniques were highly used in nutrition interventions allowing people to voice positive or negative feedbacks and other concerns that affect their behavioral change process[3,42,43,49].

An important consideration when examining the positive outcomes of CoALC in healthy lifestyle interventions is that coaching sessions are usually delivered over the telephone[24] or virtually behind the digital devices screens[44] for a preset and fixed length of time. Not only this is convenient to individuals, but it also allows them to obtain personalized support and confidential discussion while remaining in their private comfort spaces when discussing personal issues and reasons of their nutrition and health problems (e.g., weight management struggles, eating disorders, etc.)[24]. Besides, through CoALC model, a proactive dynamic relation between a qualified coach and his client is created to meet the client's needs who he is considered the expert in his life and having the answers to his own questions and problems. Some individuals benefit more from being met with such alternative proactive approach and a distinctive sort of communication than they are used to from their dietitians[45].

There are several limitations to the studies covering CoALC in nutrition and fitness interventions that should be mentioned. First, the small number of participants recruited for these studies reduces the ability to generalize the research findings. Second, a control group should be utilized for comparison to enhance the internal validity of intervention. Third, studying the coaching tools and techniques used, and identifying the topics covered within each coaching session would be valuable to explore the most impactful aspect of coaching when working on certain topics and with a segment of the population (e.g., adults with obesity). Fourth, the increase challenge to maintain a behavior change (e.g., stay physically activity) without the assistance of a life coach. Fifth, a need for rigorous large-scale empirical studies on nutrition-related matters using CoALC model[2,3,23,42,44].

Despite these potential limitations, important recommendations to inform the development of future studies based on coaching approaches can be drawn from the results of this communication.

3.3. Re-thinking nutrition and fitness systems: An argumentative scenario

Food and sports were considered mature industries suffering from massive research and development (R&D) failure as their industrial structure rely on traditional way of thinking and internal innovation[50,51]. A key reason is that their R&D strategies did not include their collaboration with external entities and the adequate data that can be obtained mainly from consumers, neither invest in new technology[51]. Recent changes in the nature of both food and fitness systems, combined with an expanding competition level in the global virtual markets, have highlighted the importance of using the "open innovation approach" as an ultimate technique for the viability and profitability of these systems[40,41]. In that respect, adapting "open innovation approach" would help to create a profitable cooperation with key partners in both nutrition and fitness industries to better understand consumers' needs and interests and act upon them by integrating the new transformative technologies (AI, ML, etc.) to generate a new knowledge framework encompassing customization and sustainability[9,41].

Wide range and sources of information have to be addressed and integrated in order to design food and fitness systems whose eventual aim is to influence the consumer's behavior by producing effective messages[15,41]. For instance, knowledge about the specific domain of food; sports and nutrition, knowledge about how individual behavior is influenced by a variety of values, beliefs, norms, attitudes, and subjective traits and feelings; and finally, knowledge about how real dialogues and effectual argumentation methods can be used to tackle social stereotypes and barriers influencing people's healthy lifestyle habits[1,4,52].

4. Discussion

The rapid and accelerating shift towards integrated and/or personalized nutrition and fitness products and services has encouraged significant changes in how related industries invest competitively in technology

innovation to understand individuals' latent and explicit needs and to develop effective solutions that meet their expectations[30,53].

Many areas of healthy lifestyle matters, from nutrition and the nutrition economic concern, to fitness, mental health, and sustainability, will see new opportunities and several challenges driven by the constant evolution of transformative technology such as AI and machine learning[30,53,54], and the new invasive movement of universal yet personalized methods of social behaviour interventions such as life and health coaching[2,49].

As the new technologies of AI, LM, eScience, and 3D printing among others continue to develop, health and sports experts and practitioners must ensure that new technologies-enabled systems are understandable, transparent, and governable. Besides, they should monitor their effectiveness and efficiency among people and that they operate ethically with human targets and values[27,35,37,40].

Developing and employing life coaching studies in nutrition and fitness interventions can support the efforts done to better understand the human and emotional intelligence[2,49]. However, in sensitive paramedical matters such as nutrition and fitness, CoALC should be used thoughtfully by only coaches who are also holders of professional certifications in nutrition and/or sports to attentively use their credible skills to help and engage individuals in charting a better and wiser path forward[2,49].

With all aspects of the food systems at play, understanding the role of AI and CoALC, and their capacities and boundaries to promote or hinder nutrition and fitness through services, processes and products is a critical skill that health decision- and policy- makers need to possess for developing professional regulations[27,28,31,49]. Herewith, dietitians, nutritionists, and sports trainers are unlikely to be replaced, at least in the near future, by AI neither by life coaches uncertified in nutrition nor sports[55].

As mediators between people, technology and the societies, public health nutritionists have a fundamental role to play in designing the safe transition to digitalized nutrition, and sports systems and services with AI and CoALC as instruments of change[2,11]. Design thinking and frameworks based on evidence-based data not only help us to think about the impact of AI and CoALC in the transition of nutrition and fitness systems but also to balance the creation of social, physical and digital artefacts with the needs of people and their communities[9,11,28,31,45,53].

The first strength of this research study was in combining technological and behavioral research outcomes for its purpose. What does this mean and why it is important to nutrition and fitness science and research? In the area of nutrition and human health, data set within a range rather than being a simple value and varies not just between individuals but also within individuals[56]. Therefore, alongside looking at the technological developments we need to address the psychosocial factors influencing dietary patterns and sports behaviors among people in different contexts[2,11,57]. Second, the argumentative scenario proposed to re-think nutrition and fitness is entirely novel and could be creatively adapted to generate effective strategies and advice on a controversial topic such as nutrition and fitness that involves values, personal attitudes and social behaviors[53].

5. Future work and implications

This review and future more specialized studies will certainly contribute to the continued advancement and refinement of the nutrition and sports fields. Specifically, the media channels and communication techniques around the AI constructs and the CoALC discourses is an area for further quantitative and qualitative research to provide clarity around the represented power of AI in food and sports systems, and the claims of efficiency that surrounds CoALC use in healthy lifestyle promotion.

Future studies can continue working on the following questions: how can responsible AI be developed as part of the decision-making in food, nutrition, and fitness systems? How can CoALC methods can be integrated

for nutrition counselling and interventions in areas such as healthy lifestyle management, dietary behaviours, and eating disorders?

Thereby, public health nutritionists should collaborate with governmental entities, technologists and life coaches: 1) to deal with all layers of meaning (beliefs, values, behaviors, etc.) influencing dietary habits and sports consumption; 2) to study and use scientific facts to understand how and what we know to bridge the inter-disciplinary gap; 3) to advocate for laws that authorize all professionals to practice to the level of their training; and 4) to develop policies and implement regulations based on nutrition and health ethics[27,30,37,45,58].

6. Conclusion

Systems thinking and transdisciplinary approaches could provide more understandings on how to better evaluate the impacts of AI concepts and CoALC (advantages, disadvantages, trade-offs), and how they are significantly changing nutrition and fitness paradigms of production and consumption. Food and sports systems must continue to build their capacities to understand, regulate, and adapt to these changes towards integrated and/or personalized nutrition and fitness matters. The suggested argumentative scenario in this study is original in using the open innovative approach, which helps to better understand consumers' needs and interests, to develop collaborative environment, and to generate effective strategies encompassing customization and sustainability concepts related to nutrition and fitness matters.

Conflict of interest

The author declares no conflict of interest.

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